

Chapter 4

Analysis

Learning Objectives

At the conclusion of this chapter, the reader will be able to:

- Apply appropriate concepts of systems development (e.g., systems development life cycle or SDLC)
- Apply and utilize project management methodology components (e.g., needs analysis, gap analysis, defining and prioritizing requirements)
- Apply appropriate concepts of process improvement (e.g., DMAIC, PDCA)
- Utilize standard visualization tools to analyze and improve current business and clinical processes (e.g., process mapping, flow diagramming, gap analysis)
- Interpret and analyze disparate data sets
- Formulate alternate processes and potential solutions for new or improved applications and/or systems
- Evaluate if a proposed solution aligns with the organization's strategic and operational plans
- Perform cost-benefit analysis to evaluate impact on issues related to healthcare systems (e.g., customer satisfaction, patient care quality, economics, access to care, business process improvement)
- Develop proposals that include recommended approaches and solutions, and plans for realizing benefits
- Analyze and interpret business documentation to promote system changes and/or implementations (e.g., RFPs, RFIs, SLAs, SOWs, NDAs, etc.)

Introduction

Different industries have adopted the use of information technology (IT) in their various operations in order to enhance growth, conform to emerging standards, attract new customers, maximize profitability and acquire business intelligence. Different sectors, however, have adopted IT use in different capacities. The health sector, like all others, is striving to enhance the acceptance of better and easier techniques available through an IT implementation, yet the average use of IT in healthcare has lagged behind other industry sectors for the better part of the last decade. According to Deloitte's 2018 Global CIO Survey, only about 4.26% of revenues were spent on technology in the healthcare services industry. This is up three quarters of a percent since the previous survey in 2017.¹ In early 2019, Forrester Research and Gartner both released predictions that spending on healthcare would increase to nearly 9%. Gartner's report though further broke down the spending, which continues to show that, although spending is up, monies are allocated mainly on supporting and maintaining the current infrastructure, not on growing and transforming the business through IT.² Healthcare has many potential benefits from IT implementation in both managerial operations and patient-related operations. These benefits may be realized through systems implementation. A common methodology that may be followed during this pursuit is the systems development life cycle (SDLC). The SDLC is a process used to develop an information system, including requirements, validation, training and user ownership through investigation/planning, analysis, design, implementation and maintenance.³ During the planning phase of the SDLC, the phase prior to the analysis phase, the initial idea for an health information system project is first developed. The feasibility, objectives and scope are examined, current problems with the existing situation are considered and a recommended solution is proposed. If the project appears to be worth pursuing the project then moves to the analysis phase. The purpose of the systems analysis phase is to understand the business requirements and to build a logical model of the new system. Requirements modeling is going to be completed, business processes are going to be described and defined, data, process and object modeling will take place, and ultimately a systems requirements document describing the management and user requirements, alternative plans and costs and an analysis of the recommendation will be produced. During the systems analysis phase, the following objectives should be met:⁴

- Gather, analyze and validate technical, functional and nonfunctional requirements.
- Evaluate the alternatives and prioritize the requirements.
- Examine the information needs of end users and establish the systems goals.
- Create software, hardware and network requirements documentation.

Requirements gathering in this phase is key. Lack of end user input can mean a weak analysis. A weak analysis leads to poor design, which can lead to failed projects.

Healthcare Problems and Opportunities for IT Implementation

Healthcare globally is going through dynamic changes in several ways. Improvements to healthcare information systems emerge from a need for change. Either the existing system does not meet the evolving needs of the program or there is an understanding that emerging technologies allow for radically better systems. In response, a small group, or a project champion, identifies this need and then tries to mobilize a larger group of stakeholders. During this phase, systems analysis, the perceived gaps and opportunities are documented, with a strong focus on describing the desired benefits and why. It may include the development of a high-level business case that compares the benefit with estimated costs. To begin, let's look generally at problems plaguing traditional healthcare systems and then potential opportunities to address these issues.

Problems with Traditional Healthcare Systems

Overall, there are some general problems with the traditional healthcare systems. These may include:

- Poor quality of health information including redundancy and inconsistent standards for the collection and sharing information.
- Inability to obtain health information at the time and place where it is needed.
- The data collected in health records is limited.
- Some registers in health exist only in paper form, which limits quick access to them.
- Inadequate procedures for the implementation of information systems not related to the relevant organizational changes.
- Existing solutions do not ensure interoperability and the lack of co-operation between systems makes management of information impossible and adversely affects the accuracy, integrity, comparability and completeness of data.
- To this point, systems have been developed primarily to support the work of the administrative unit, while to a small extent adjusted to the needs of patients, doctors and other users.
- Lack of computerized practitioner order information and histories for drugs and other substances, medical supplies, catalogs and lab test results.
- Lack an integrated, interoperable electronic health record, image and film archiving and associated communication systems, the result analysis

mechanism for ordinary patient processes such as lab tests and drug prescriptions, prescription error alert systems and electronic monitoring of high care patients.

Opportunities with Advanced Healthcare Systems

As we look toward advanced healthcare systems, there are many opportunities. Hospital information system (HIS), healthcare information system and patient data management system (PDMS), all these terms refer to the integrated information systems in the healthcare sector. They are complete solutions for managing medical, administrative, financial and legal data. The overall aim of a HIS is to provide support for patient care, achieve optimal financial performance and streamline administration. These systems include the integration of clinical systems, financial systems and administrative systems. Benefits of integrated healthcare systems include:

Operational

- Increases productivity, reduces cost, improves data quality, improves data sharing/flow, provides better access to data, provides easier exchange of data, improves data presentation, reduces medical errors and helps achieve satisfaction.

Managerial

- Improves managerial control, provides more understanding and control of processes, supports decision-making, improves allocation of resources, improves quality of care provided, improves work efficiency, increases performance and increases return on investment.

Strategic

- Supports more effective planning, increases synchronous-asynchronous collaboration among actors (actor refers to all human and non-human users that interact with the healthcare system), improves relationships with suppliers, improves knowledge sharing, improves population's health and increases survival rates and quality of life.

IT Infrastructure

- Promotes reusability of objects, reduces development risk, supports the use of e-healthcare and telemedicine-based patient support models, achieves non-invasive solutions, achieves process integration, provides object/

components integration, provides data integration, provides real-time integration, integrates custom systems and integrates packaged systems and integrated e-business solutions.

Organizational

- Reduces need for hospitalization or length of stay, reduces waiting times, reduces cancelled operations, achieves effective clinical and administrative management, increases business efficiency, supports clinical decision-making, results in reliable data, increases data analysis and reduces paper work processes.

The major avenues of opportunities for change are spread across clinical, administrative and financial functions as well as infrastructure.

Clinical Functions

A significant percentage of modern healthcare facilities are using IT systems in clinical operations. However, the majority of units are still dependent on traditionally used systems, such as physical patients' document keeping, lab reports, drug administration history and other functions. While much progress has been made in these areas over the past couple of decades, we still have a long way to go before we achieve a global, interoperable healthcare system in all types of healthcare settings.

Applications for Clinical Functions

Electronic health records (EHRs) involve standardizing the way in which patients' records are entered, stored and retrieved, not just within an organization, but across different hospitals, caregivers, government-controlled organizations and other interested parties. The biggest challenge regarding EHRs has been the establishment of an industry standard so that an efficient workflow can be realized that would allow for seamless retrieval and use of records for patients, even when patients are moved to units or facilities other than where they were initially treated.

This kind of data pool would imply a dedicated system with necessary checks and balances to prevent unauthorized access to and manipulation of patient records, while, at the same time, enabling data entry by different care providers when patients make additional visits to any facility. This concept is delicate due to the potential of malicious addition or manipulation of patient data by different staff in different facilities. Moreover, a lack of universal standards in proper coding and categorization of prescriptions and procedures has hindered the implementation of interoperable EHR systems in the last two decades. This problem can now be sufficiently handled by high-end software applications that are being developed by individual and corporate research entities.

An example of one type of system being pursued is computerized practitioner order entry (CPOE). CPOE may replace conventional order cataloging and fulfillment in a manner that will enhance tracking, logistic synchronization and cost-effectiveness. Another example of a system is a clinical decision-support system (CDSS), which, in its basic form, will give informative guidelines to practitioners regarding medication and procedures, including warning systems relating to high-risk medications and processes. In addition, the picture archiving and communication system (PACS) integrates inputs from multiple radiological and diagnostic tools to allow easy, consistent and accurate treatment of different conditions, while radio frequency identification (RFID) may help to track patients within a medical unit without the need to restrict them to a particular location or allocate a nurse to them. There are also monitoring systems that may collect vital signs which may include pulse rate, temperature level, blood pressure and other metabolic/respiratory signals. Benefits of such a system, if properly collected, stored and secured, when integrated with other dedicated software applications, may shorten treatment time, allow more freedom and lead to cost efficiency and better resource utilization within a hospital or other healthcare facility. Automated dispensing machines (ADMs) will aid in drug dispensing, while electronic materials management (EMM) systems will operate like the resource planning systems used in other sectors to manage information processing regarding pharmaceuticals, new drug development and coding, among other functions. Such a system could reduce medication errors, which, per a report from 2016 found that adverse drug events (ADEs) account for more than 3.5 million physician office visits and 1 million emergency department visits each year. This same report also stated that it is believed that preventable medication errors impact more than 7 million patients and cost almost \$21 billion annually across all care settings.⁵

Administrative and Financial Services

Functions that could be enhanced through investment in IT in the administrative category include general ledger operations, such as revenue and cash flow, expenses, purchases and other day-to-day transactions. Other functions are billing, cost accounting systems, payroll, personnel management and integrated human resource functions, patient registration and booking and electronic management of materials, among others.

Applications for Administration and Finance

IT may find many basic as well as advanced applications in administrative and financial services. Human resource management has experienced radical changes in operational methods as a result of IT implementations. Systems for employee management, role definition, reward and recognition support and performance development have been successfully automated thanks to dedicated

software such as enterprise relational database management systems (RDBMSs). Such systems allow easy, timely and accurate workflow management in human resource mobilization and development, saving time and costs that would otherwise be allocated for additional staff. Other functions, such as payroll, budgeting, internal audits and strategic planning, have also been made easier, more precise and tailor-made for specific analytical objectives without incurring additional monthly or yearly charges due to the use of IT systems. Patient registration and tracking can become more enhanced and efficient, and access to the online statistics of every facility within an area may be useful in referrals and in discharge notification, enabling time saving and better emergency handling.

Infrastructure

Infrastructure is a broad category that incorporates various equipment with diverse applications, both general and specific. Current security standards have shifted toward biometric sensors for movement and access control in many major private and public buildings and premises. These security standards enhance accountability in system access and support user logging, which enhances safety and responsibility among authorized personnel. The healthcare sector could, perhaps, benefit the most from such systems, given the delicate nature of confidentiality requirements involved in patient records access and dissemination. Biometric sensors typically used include fingerprint or palm scanners, voice recognition systems and eye scanners, among others. Other more dedicated systems include bar coding systems for medication grouping, ordering, cataloging and stock control. Security infrastructure may also include closed-circuit TV cameras and night infrared cameras.

Security-Related Applications

Since IT relates to healthcare security, it may find many uses, some of which may not be achieved in other ways. Patient information access logging is important in ensuring confidentiality and professionalism in the way patients are treated. It increases patients' confidence in their practitioners and boosts their trust levels. In addition, the use of biometric systems will eliminate to a large extent, ambiguity in accountability in delicate cases due to their high precision levels and extremely low chances of identity theft or manipulation, unlike conventional security protocols when any person with forced access to pass codes may steal information. In addition, healthcare research facilities may hold expensive machinery that, if it falls into wrong hands, may be used in ways detrimental to society. For instance, ultra-modern DNA synthesis machines, if used by experts, may find applications in the terrorist underworld. Other chemicals and drugs in healthcare facilities may also be abused or sold to unsuspecting people as legitimate prescriptions and lead to catastrophic consequences. Such security measures cannot be overlooked, and government control is restricting the use of

certain machinery and equipment to high-security facilities, limiting the range of services that healthcare units with lower security may offer.

Another broad category of infrastructure has to do with network development and all associated controls. Medicare processes large amounts of information internally, not to mention the external linkage requirements associated with referrals and national accountability reports that must be processed and sent to government control and data collection agencies and other industry regulatory bodies. The baseline network infrastructure includes servers, end user computer stations, switches, network access points, all associated cabling and external access infrastructure. While very elaborate high-level applications have been incorporated into network infrastructures in a significant number of healthcare facilities, the majority of care units are using their network support equipment for only slightly more than baseline uses, such as record keeping and document sharing.

Needs Analysis in Healthcare Facilities

In order to develop a proper proposal for sustainable IT supplementation in the core processes of the healthcare sector, it is important to identify the main challenges in the sector and specifically those needs that can be sufficiently met by the implementation of sustainable, secure and cost-efficient IT practices. This section will give a detailed needs analysis to lay the foundation for the chapter. The analysis focuses on requirements that may be categorized as operational, administrative, or industry related. During the needs analysis, the problem will be further characterized, a cost-benefit feasibility study will be performed, the scope and value will be defined and the framework for what the system will do is established. The needs analysis may also be referred to as a gap analysis. A gap analysis is a method of assessing the differences in performance between an organizations systems to determine whether business requirements are being met and, if not, what steps should be taken to ensure they are met successfully.⁶ These gaps help inform the overall needs assessment. The following text will also describe a number of processes and tools that will aide in establishing the gaps and informing the new system requirements.

Operational Needs

Healthcare facilities need to streamline their core administrative and financial operations with the current global standards in order to foster interoperability in record keeping and analysis with other stakeholders, investors and business partners. Currently, healthcare as an industry is behind average industry standards in IT acceptance. Such processes as payment processing, e-bill systems, human resource systems, stock intake, auditing and other similar functions can be sufficiently integrated with the use of developing software.⁷ In order for a

system to be sustainable and standard, it is necessary to select a universally accepted platform for data storage and analysis in which organizations may pool data relating to logistics and facilities. Financial as well as private human resource information does not need to be pooled in a central storage facility, but adopting software dedicated to easing these functions on a private level is necessary in order to reduce costs, enhance operational efficiency and increase profitability. Operational needs may be broken down into several areas.

Staff Productivity and Satisfaction

The use of IT may reduce time wasted by operational staff performing administrative work and enhance patient attendance time, which is the key need for patients. It will also reduce unnecessary routines in patient care and reduce work of clinical staff due to rigorous, non-work-related duties. Additionally, it will improve employee satisfaction and reduce fatigue due to extensive overtime schedules. Better productivity will invariably lead to increased patient volumes.

Increased Revenue and Cost Optimization

Increased visitor capacity per unit may boost revenues for a care unit due to a larger number of admissions and discharges per month following shortened lengths of stay, reduced unit costs for bulk purchases and improved capability to meet overhead expenses. Cost optimization needs to be realized through bulk purchases, efficient stock control and reduced cost per day for each patient. In this regard, IT practices will save costs for the unit as well as daily treatment and accommodation charges to the customer.

Patient Safety

A significant number of deaths and serious medical malpractice cases are reported each year due to errors in treatment, procedures or prescriptions. The major cases involve ADEs due to wrong prescriptions that affect patients negatively, admissions following adverse drug events, errors in surgical procedures, blood transfusions and malpractice expenses such as corrective procedures, court litigations and compensations. There is an urgent need to reduce such occurrences, many of which can be satisfactorily handled by the application of proper IT processes.

Quality of Care

Patient quality of care deals with the satisfaction that patients get from care providers' efforts to resolve their problems. It may involve time of delay, time of treatment, appropriateness of procedures used and drugs administered and the levels of professionalism, confidentiality and courtesy of the staff. Moreover, it

may involve specific professional services, such as recognition and accreditations, complication management, physician or nurse time with patients and reduced length of stay.⁷

Patient Access to Services

Apart from the length of stay, patients are concerned with delay time for such processes as lab reports, billing, online services such as viewing and scheduling, preventive care management and outpatient care appointment bookings. There is a need to upgrade systems that can be automated to handle most of the routine work not requiring case-specific diagnosis, such as remote patient appointment bookings and all associated alerts on scheduling, integrated lab linkage with other hospital systems that eliminates the need for extended physical queues at facilities, and electronic procedures for alternative bill settlement by customers. If proper systems are established to meet the outlined objectives, other needs relating to healthcare that cannot be quantified but lie at the core of healthcare provision will also be realized. This will lead to nonmonetary benefits such as good patient–physician relationships and improved community health.⁷

Tools for Accomplishing the Needs Analysis

Needs analysis can be conducted through a variety of tools. The most common include observation, interviews, review of documentation, surveys and data analysis.

Needs Summary

The foregoing discussion highlights the need for all-around IT supplementation to help healthcare catch up with other sectors in terms of modernization and integration. In essence, what is required is sufficient planning to implement safe, sustainable and cost-effective IT practices to help healthcare in (1) administrative, (2) operational, (3) patient-related and (4) industry-related functions. There is a need for a seamless backbone IT platform that integrates these four needs, as well as sustainable controls for the IT implementation to ensure it remains secure, serves the maximum purpose possible and is practical for universal adaptability in order to satisfy the core concern within various healthcare institutions, which is the integration of policy implementation.

Needs Prioritization

While all the needs listed above are urgent and important, there are certain ones that must be prioritized in order for IT acceptance in healthcare to stand. These processes are the backbone of healthcare, and all other requirements

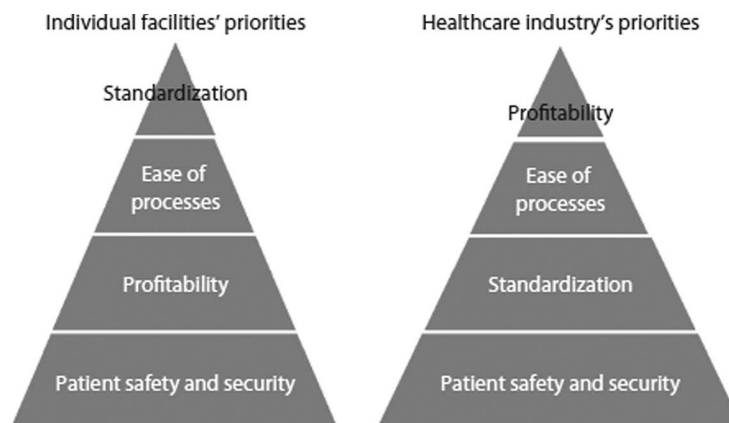


Figure 4.1 Differing priorities of individual facilities and the healthcare industry.

are built on them. For instance, patient security and safety are core driving factors for any practitioner, and they surpass the need for good bookkeeping or profit optimization. Without proper observance of fundamental safety concerns, healthcare units are likely to face legal implications that could cause them to lose their license, rendering futile any advancement they may have in their other operations. This section will therefore seek to address the need for prioritization of IT acceptance in healthcare facilities based on the hierarchy of the needs model. The needs prioritization process helps drive the likelihood of project acceptance. The primary priority from an individual facility's perspective is patient safety, followed by profitability, then ease of processes and lastly, industry standardization. From the healthcare industry's perspective, the priorities are likely to be patient safety and security, professionalism, standardization, profitability and ease of processes. Obviously, the ease of processes is in most cases tied with profitability.⁸ The project must therefore address IT implementation issues from both perspectives and attempt to strike a balance. [Figure 4.1](#) illustrates the differing priorities of individual facilities and the healthcare industry.

Workflow and Process Mapping

Workflow and process mapping serve as mechanisms by which to understand current processes and how work is performed to begin the change management process and serve to support the functional data and technical strategies.⁹ These two methods can also help identify broken processes and provide an opportunity to address them before a system automates them. This also helps recognize the need for process improvement through automation. Process mapping guides functional specifications where a product may not address all functionality an organization may need or want. It helps visualize the need for standard data structures.⁹ This can also be termed process redesign or process

reengineering. Workflow aids system configuration during implementation, provides scenarios to create test cases from and guides new users of the system regarding how the process with change with the new system. Workflow and process mapping identify how work is currently performed and the sequence of steps involved. There are a variety of forms these diagrams. Some tools include activity diagrams, swim lane charts, data flow diagrams, system flowcharts, entity relationship diagrams, class diagrams and uses cases.

Current Clinical Processes

Operations and processes in the healthcare sector can be analyzed in four broad categories: administrative and financial, operational, process flow and standardization.

Figures 4.2 and 4.3 present typical process flow diagrams that aid in identifying areas of two healthcare processes that are manageable using IT.¹⁰ Process diagrams and flowcharts are a visual representation of a process that show the boundaries of the process, the steps and the sequence in which the steps take place. These visual representation will use standard symbols, but different approaches and different symbol sets may be used, e.g. ISO 5807 and Unified Modeling Language (UML).

Figure 4.2 shows the process flow for a typical client briefing about lab reports. A nurse will usually try to reach a patient more than four times in stated durations, usually from a few hours to a day. This process takes time, delays other functions and consequently leads to fewer patients served per day. The proper IT implementation, even on the internal level, may allow convenient patient briefing and follow-up using trusted e-mail services, among other channels. Patients can usually be given the option to choose their preferred channel of communication before leaving the hospital or other care facility.

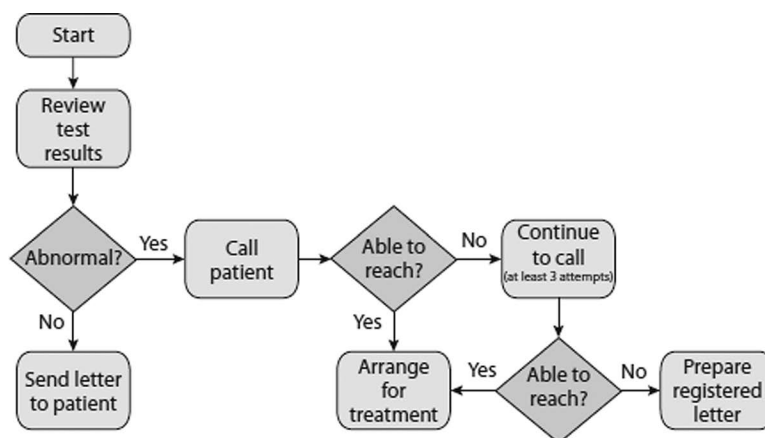


Figure 4.2 Process 1: Laboratory results patient information process.

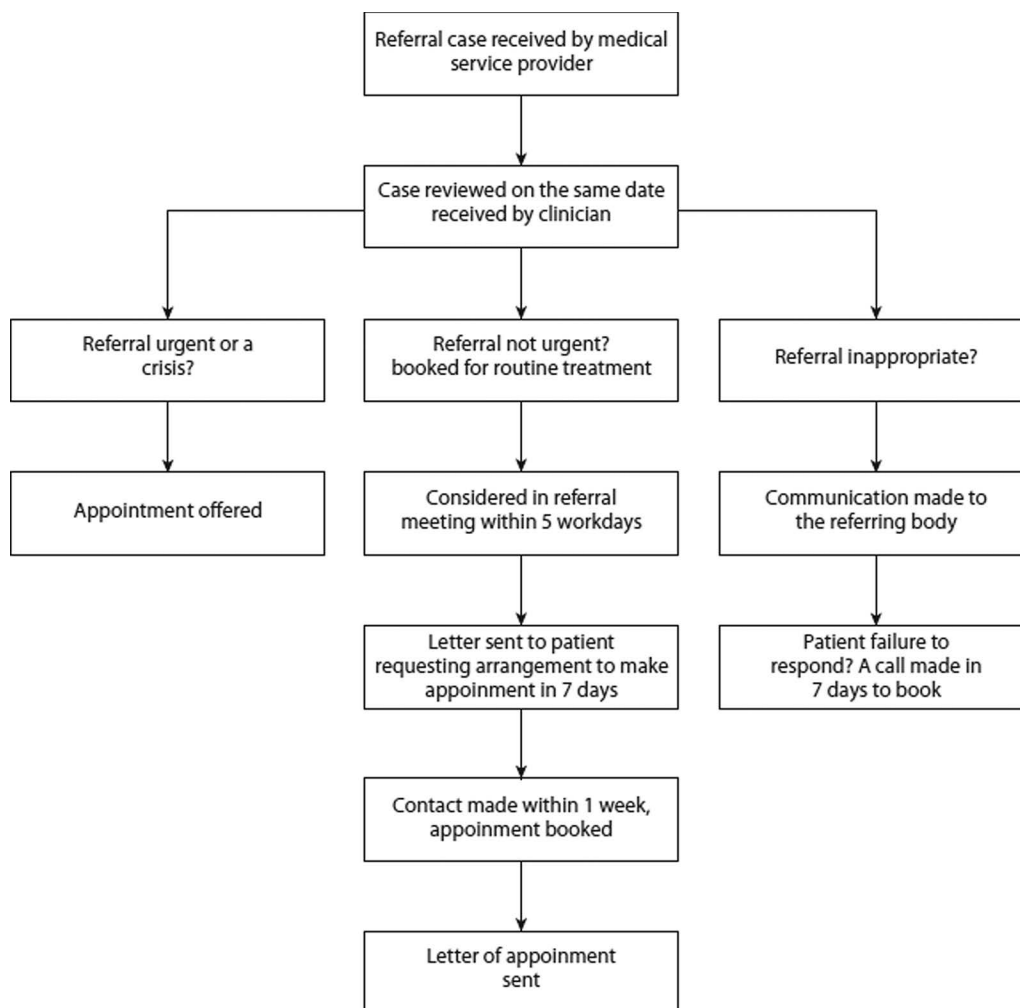


Figure 4.3 Process 2: Referral-patient booking process.

A typical referral process involves even more delay. The referral-patient booking process is diagrammed in [Figure 4.3](#).¹¹ The figure clearly demonstrates delays introduced in current healthcare systems due to lack of integration between the communication and decision-making systems involving care providers, referral centers and patients. In the workflow diagram, it may be noted that a referral patient may wait up to two weeks between the date of referral and the date of appointment booking solely due to communication and work arrangement delays. Referrals may not appear urgent on the reported data sheet, but patients' situations may become aggravated during the waiting period when they are unable to obtain help. As a result, patient services may be greatly compromised due to the systems' inefficiency. In addition, the lengthy waiting period can be greatly reduced if proper IT policies that incorporate remote meetings, such as video and audio conferencing, are implemented. The time spent between contacting a patient and receiving a response constitutes service degradation for the patient and revenue loss for the care provider.

A reduced number of patients are seen per day; therefore, customer satisfaction levels may also decline. While authentication issues may be cited as the reason for insistence on the use of official letters by care providers, the bulk of the processes requiring care provider–client correspondence involve non-vital documents, such as requests for bookings. A possible method of bypassing this hindrance through the IT-based communication implementation is to develop a web-based communication and client support system that would allow secure communication between the customer and the care provider. In this platform, customers would be able to receive e-mails and respond to booking notifications. Modern day patient portals are beginning to address this need, but the implementation and use of these systems is still lagging.

In addition, digital signing is a standard that is progressively being adopted by many industry sectors and is a concept that may be beneficial to healthcare providers when they send documents requiring authorization or authentication. As an alternative, the use of registered mailing services may greatly reduce the feedback duration for sensitive medical cases. Apart from the operational perspective, billing systems and other workflow routines in most facilities are also very inefficient. The entire process, which includes a medical history review, booking to be attended by the physician, physician duration, prescription, queuing at the pharmacy and bill settlement, involves avoidable delays. These work stages can be sufficiently improved by computer-aided work management and decision-making.

As workflows begin to be examined naturally other key factors to the analysis process will begin to take form. This really begins the requirements gathering processes as well.

Functional Needs Assessment

The functional needs assessment describes the key capabilities or application requirements for achieving the benefits of the system as the organization has envisioned it.⁹ This process is important because every organization begins from a different starting point, every organization has different needs and every vendor offers a different approach.

This process is best achieved through surveying users and reviewing use cases. Users should be asked to identify what functionality they need and perhaps rank/prioritize them. Although in the early stages of the project a user's understanding of what may be possible may be limited, it is still important to understand this as you may need to plan for additional functionality in later phases of the project. Knowing this helps ensure that you are selecting a product that will best meet all these needs, including current and potential future needs. You may also be able to identify users who have had exposure to different systems and will be able to provide

feedback regarding their experiences. This also allows users to be more engaged in the process which is a critical component of implementation success.

The use case approach is often easier for clinicians to understand. A use case is a scenario that essentially describes a system behavior as it responds to a request that originates outside of that system. It will describe the interaction between the actor who initiated the interaction (such as a clinician) and the system itself. Clinicians can begin to form these use cases as they consider patient care events. From these depictions of scenarios, additional visualizations can be created, e.g. process diagrams, but ultimately it will result in a listing of functional requirements to achieve the patient care use case. As part of this, current functional capabilities can be inventoried which will help users see the scope of current capabilities, as well as establish a foundation on which to understand what essential functional capability may be missing and is needed in support of other, more robust capabilities.

Requirements Analysis

The requirements analysis is going to be the documented record of what the system actually does. It is a critical component to keep the project aligned with the identified scope. It is essential to the testing process, as the information gathered in the requirements analysis will produce test cases that can then be used to validate that the system meets the project requirements. These use cases will begin with a high-level description of the process and will furthermore include a detailed description of each requirement. Often use cases will also include a graphical depiction. This document will describe the future state and is the primary input document for estimating resources, cost and time needed for the project. It will also take into account the needs assessment and further inform the needs prioritization. Requirements are often categorized as follows: functional and workflow, reporting/analysis capabilities, regulatory requirement, data/database, security, system performance and response time, disaster recovery, platform compatibility, interface and interoperability, physical plant consideration, client devices and network.

Document Analysis

In addition to documenting the sequence of steps and decision points in the process, workflow and process mapping should also be accompanied by a collection of all of the associated documents and a documents analysis should be performed. This will also help define the data requirements associated with each process. When working with a vendor they will sometimes provide organizations with a tool to conduct this, while other times a spreadsheet is just as efficient and effective.⁹

Additional Inventories

In addition to the various information-gathering techniques described previously, some additional inventories to be considered include an applications inventory and a reports inventory. In the applications inventory the organization identifies all of the applications that currently exist and how they may or may not be related to one another. This too will help identify the functional requirements of the new system as it leverages and interacts with current applications. It may also help to identify additional applications that could be replaced by the new system. The reports inventory serves as a document of all of the current reports being used/produced by current systems. Again, this too can inform the functional assessment regarding what may need to be produced from the new system.

Process Improvement

These various steps may also lead to process improvement opportunities throughout the analysis phase, and the project as a whole. As workflows and processes are examined and evaluated any improvement opportunities that can be addressed prior to the system design may save time in the long run and produce a better system. Process improvement involves the business practice of identifying, analyzing and improving existing business processes to optimize performance, meet best practice standards, or simply improve quality and the user experience for customers and end users. Process improvement can have several different names such as business process management (BPM), business process improvement (BPI), business process re-engineering and continual improvement process (CIP).¹²

Everything everyone does in an organization is part of a process. To improve the organization, you must focus on the processes. Process improvement is a fundamental step in business management and here are many different accepted ways to improve process. A couple of examples are the DMAIC and PDCA models.

DMAIC

DMAIC stands for define, measure, analyze, improve and control. The DMAIC model is a data-driven quality strategy used to improve processes.

- Define the opportunity for improvement
- Measure the performance of the existing process
- Analyze the process to find any deficiencies
- Improve the process by addressing the root causes uncovered
- Control the improved process and future processes performance to correct deviations before they result in defects and to prevent reverting back to the “old way”

PDCA/PDSA

There is also the PDCA/PDSA model, which stands for plan, do, check/study and act. This is a cyclical model that is also iterative, following a four-stage management method used for the control and continuous improvement of processes.

■ Plan

- Identify and analyze the problem or opportunity
- Develop hypotheses about the cause of the problem
- Decide which to test

■ Do

- Test the potential solution on a small scale
- Measure results

■ Check/Study

- Study results
- Measure effectiveness
- Decide whether the hypotheses are supported by the data or not

■ Act

- If the pilot solution is successful, implement it

Deficiencies in Current IT Healthcare Practices

From the discussion provided above regarding process flows in the healthcare sector's IT policies and practices, it can be seen that there are still some obstacles to customer satisfaction, healthcare business profitability and industry integration. These obstacles, which are restricting the sector's potential growth, will be analyzed in this section based on the industry's key performance indicators (KPIs). Client satisfaction through good services and support, business growth through revenue generation, efficient service process arrangement and proper implementation integration can be attained through the corporate initiative.

Patient Support and Satisfaction

Unnecessarily high numbers of patients leave healthcare units without treatment due to long waits for service. Physicians see fewer patients per day when lengthy delays are caused by lack of proper equipment. Such slow systems also lead to extra work for the available personnel, which causes degradation in service quality. Proper patient support and safety also have a

correlation with employee retention and employee satisfaction. When healthcare workers are overwhelmed, they tend to perform more poorly and have higher exit rates than workers in places where IT supports workflow management.

Reduction in Revenue Generation

Many healthcare systems are not efficient in revenue generation, and there is a possibility for improvement through IT innovation. Delays in customer service lead to low numbers of attended patients per day, which results in revenue losses. In addition, many patients leave unattended, which leads to business loss. On top of this, healthcare facilities lose potential clients who might have been referred by existing customers if they had not been annoyed by long wait times. In addition to losing business, healthcare units incur extra expenses due to overtime work by doctors and nurses when workloads are heavy. These increased operational expenses and reduced business revenue contribute to overall reduction in business profitability. Inefficient facilities also require a significantly higher number of workers to cope with the physical workflow and lack of integration, which results in extra costs.¹³

Prescription Errors

The current healthcare system does not fully utilize software-supported decision-making for medication orders, even though it would greatly enhance the checking of prescriptions to ensure proper diagnosis support, drug type and dosage. This has resulted in numerous prescription errors, which may lead to adverse patient reactions and deaths. Improper prescriptions have also led to an increase in drug-related claims, legal penalties, license withdrawals and other challenges that could be avoided by proper IT support.

Industry Standardization

Continued lack of healthcare IT standards has led to the loss of tremendous opportunities to improve interoperability, data sharing and transitions of care. This situation will be significantly changed when sustainable policy frameworks can be agreed upon and implemented by IT experts and enforced by government to expand the implementation of IT integration.

Alternative Approaches to Current Healthcare Processes

To increase revenue, provide a seamless link between facilities and regions and improve the patient experience in healthcare workflows, certain IT-based procedures can be implemented. The following sections explore these alternatives according to the deficiency area.

Industry Standardization

The Healthcare Information Technology Standards Panel (HITSP) and the Office of the National Coordinator (ONC) have made many positive achievements in IT integration over the last couple of decades. While there are numerous challenges in such an attempt and many success stories, we continue to work toward this accomplishment through different avenues.¹⁴ Future initiatives might include a new integrated architecture that would meet a cross section of market needs. This platform would be such as to link with all major existing software and hardware configurations in the market, such as EHRs, data management systems (DMSs) and imaging programs, among others.

Alternative Ways to Reduce Prescription Errors

Unlike the global integration challenge, prescription errors can be handled from a local perspective while awaiting the market integration standards. Many software applications are dedicated to prescription information and decision-support systems. Avoidance of ADEs is one major KPI that can be addressed by IT implementation in the healthcare sector. One such software category is a CDSS, which provides updated information regarding recommendations for prescriptions to nurses, physicians and other qualified healthcare workers. This system is typically integrated with the EHR and CPOE systems in order to perform a proper scenario analysis with appropriate patient backup before a provider writes a prescription. Many commercially available software options offer this functionality.

Alternative Processes for Revenue Generation

Financial processes are, perhaps, the easiest to simulate in IT process integration due to their general nature and resemblance to other industries' financial processes. Revenue generation draws primarily from workflow optimization, which mainly seeks to reduce query time and thus queue time, reduce waiting time through the implementation of fast patient data retrieval and diagnostic support and reduce laboratory scheduling and patient briefing time by enhancing fast decision-relay procedures and online client information alternatives. Online support may be an easy way for patients to obtain their lab results electronically signed by their care providers without having to wait in queue. Such a system is not out of reach and may be developed by most modern web applications. In addition to saving time and encouraging more customers, an IT-based process would lead to higher levels of perceived efficiency, productivity, better customer experiences and satisfaction and therefore more referrals.

This chain of flow would, in turn, generate more revenue and lead to higher growth rates. Many software applications have support for workflow management, and most of them do not require very high initial investments in comparison to the average capital requirements of a modern healthcare facility.

Comparative Analysis of Alternatives

This section summarizes the current versus expected status of various aspects of a healthcare IT implementation.

Intended achievements attributable to the new system implementation are presented in [Table 4.1](#) and supported by various research into IT-related healthcare practices. While the extent to which key industry players may benefit from the implementation of these new IT practices may vary, it is likely

Table 4.1 Comparative Analysis of Core Processes in Healthcare

<i>Variables</i>	<i>Current Status</i>	<i>IT-Enhanced Status</i>
Patient service	Lengthy queue times, typically 20 minutes Long durations for record retrieval Long wait times for lab reports, prescriptions and correspondence	Queue times reduced by up to two times Instant record retrieval Shortened lab report delays, instant prescription information and instant messaging
Service processes	Manually coordinated Delays and inefficiency in processes Duplicated work and delayed completion Lack of feedback and rigid decision-making	Computer simulated and optimized Very efficient monitoring Proper process scheduling Decisions based on feedback with continuous dynamic optimization
Erroneous prescriptions	Prevalent errors, with numerous legal and financial implications High admission rates for ADEs Capacity limited by number of prescription-related admissions	Greatly reduced number of prescription errors and minimal revenue loss Greatly reduced admissions due to ADEs More capacity for new cases due to reduction of ADEs
Industry standardization	Highly localized Business losses due to lack of interoperability Limited data access	Universally available Enhanced business due to interoperability Optimized data access and improved quality of care

that the net results will be beneficial.¹⁵ In addition, the capital implications of implementing IT-based healthcare support systems are within investment range. Long-term investment costs should be recoverable from the benefits obtained from healthcare interoperability.

Work Plan Development

Also part of this phase is the start of the development of the work plan. A work plan is aimed at establishing a step-by-step implementation setup for a project, including materials and equipment layout, intended workflow processes, managing the time, analyzing processes and evaluating outcomes. In the healthcare IT implementation plan, a proper work plan involves putting in place procedures to realize the needs for IT acceptance by healthcare facilities, starting with the primary priorities and proceeding to other priorities.⁶ Sample elements of a work plan are presented below.

Executive Summary

This project is aimed at analyzing the efficiency of the current systems in healthcare and assessing the situation with the purpose of providing a working alternative that is IT enhanced and will lead to the realization of target objectives of the sector. The plan will provide the project implementation phases as well as define specific operations to be carried out during each phase.

Introduction and Background

The implementation of IT policies in healthcare has been faced with many challenges, rendering the process complex and nonstandardized.¹⁵ Establishing a comprehensive industry standardization process has been impossible due to various individual interests among care providers, drug and device manufacturers, pharmaceutical companies and regulating bodies. Thus, there has been a diverse range of new drugs and other medication practices localized in small market segments without proper administration and regulation. In addition, a wide network of healthcare facilities operating in different geographical, economic, technological and cultural settings has made it difficult for the various stakeholders to come together and develop an enhanced global EHR system that will ensure standardization of procedures, leading to a net lag in technology acceptance in the healthcare sector. The IT sector, however, has advanced and infiltrated all major sectors on the global platform, forcing all industries to confirm or become outdated. This is the case in the healthcare sector as well, prompting stakeholders to start seeking urgent and sustainable methods in preparation for standardization and alignment with emerging trends on the global IT platform.

Goals and Objectives

The goal of this work is to find a structure for IT integration in the healthcare sector's main processes, which includes cost-effectiveness, patient safety and care, ease of processes and industry standardization. To this end, specific objectives must be identified initially that include the following:

- Evaluation of the current operational situation in each healthcare facility. This step will include analysis of current clinical processes such as process mapping. It will also document the current trends that can be found in healthcare procedures, including administrative and operational trends and integration of workflows.
- Identification of the major problems in these processes with respect to the optimization of the IT use. This stage will involve comparing the efficiency of the current processes with the efficiency typically achievable in a similar setting with IT implementation.
- Identification of alternative solutions to these problems through the implementation of IT policies. This process will involve providing alternative solutions to the current processes and include software and hardware recommendations, as well as a proposal for a working interface with existing resources.
- Carrying out a comparative analysis of the alternative processes and the original routines. Flow charts, tables, process flows and other analytic tools will show relationships and deviations between the systems, thereby guiding the policy implementation decisions.
- Evaluation of alternative solutions in alignment with the specific objectives set out in the plan. This stage will involve rethinking the project intentions and comparing them with realized outcomes to assess efficiency.
- Evaluation of the ethical, legal, social and economic implications of the alternatives through a comprehensive cost-benefit analysis.
- Developing a proposal for implementing recommendations and following up after the project to enable quality improvement.

Resources

The plan will usually involve the purchase of additional materials, as well as the hiring of support staff. The major resources should be assigned as follows:

- Personnel - The category will involve all people contracted in the rollout process, including software support teams, simulation teams, project evaluation teams, engineers in various capacities, technical teams and other necessary personnel.
- Partners - These may be governments, government-sponsored partners, nongovernment organizations and private investment agencies, among other stakeholders.

- Equipment - This includes facilities and computers, software and related capital purchases.
- Legal and regulatory infrastructure intended for the implementation of IT.

Work Plan Accountability

The resources available for the implementation of a proposal will be regulated and governed by a project management or steering committee that will be responsible for budgetary allocations, expenditure monitoring and accounts reconciliation. In addition, time management will be essential in order to complete the phases of the project implementation within the specified timeframe.

Proposal Evaluation

The organizational business plan for most healthcare facilities has four major objectives: patient satisfaction, revenue generation, efficient processes that cut costs and increase profits and conformity to industry standards. The proposed solution model should meet all those requirements. First, patient satisfaction is achieved through efficient processes that reduce delay time, enhance the customer experience and offer a good follow-up on patient issues. Second, revenue generation is enhanced through shortened staff time spent per patient, which leads to increased daily patient attendance figures. Third, efficiency in the process flows reduces work duplication and improves service quality, both of which increase revenue generation through cost cutting. Fourth, the proposal expressly seeks to establish a platform for standardization of healthcare IT processes. In summary, the proposed solution enhances the general business requirements and objectives for the average healthcare provider and ultimately the patient. Additionally, the following tools may also strengthen the proposal.

Cost–Benefit Feasibility Study

The stakeholders who stand to gain or lose due to this policy implementation are healthcare facilities, patients, medical practitioners' representative bodies, drug and medical equipment manufacturers, state and federal governments and related authorities and computer equipment and software manufacturers and vendors. The expected cost–benefit elements include finance, service quality, control and time, among others. The important variables to be considered in the analysis are the time of implementation, cost of implementation, alternatives to the proposal, impact on stakeholders, impact on external parties, sustainability versus ongoing operating costs per year and value of time to be used in the implementation.

Table 4.2 provides a sample of a cost–benefit feasibility study for the enhanced IT project.

The anticipated outcome of the cost–benefit feasibility study predicts a continuous reduction in investment costs and a net increment in revenue generation for manufacturers of products that support or can be adapted to the

Table 4.2 Cost–Benefit Feasibility Study of Proposed Healthcare IT Implementation

<i>Variables</i>	<i>Costs</i>	<i>Benefits</i>
Financial implications	• Internal equipment and software upgrade • Licensing fees • Loss of investment for users of nonstandard applications	• Increased revenues of up to 50% per year • Access to the global interoperability platform
Customers	• Possible compromise of privacy and safety due to malicious information access and manipulation	• Improved services, care and access to records • Reduction of prescription errors and resources wasted due to ADEs
Drug and medical equipment manufacturers and related bodies	• Possible losses in equipment standardization, but generally minimal negative effects	• Better policy implementation due to globalization of standards • Less counterfeiting and associated losses • Possibility of forming stronger representative bodies
Governments standards	• Reduced control of medical and healthcare practices for member states • Possible realignment of the structure to include international representation	• Increased diplomatic ties • Better availability of globally competitive healthcare standards for citizens • Achievement of core objective of standardization of healthcare
Hardware and software developers and manufacturers	• Possible loss of business for companies whose products fail to support the new standards	• Numerous opportunities for new developments and increase in sales

new standard, healthcare facilities and drug and medical equipment manufacturers. Similarly, the net long-term outcome for the patient is better service, improved quality of care and greater satisfaction.

Proposal Sensitivity Analysis

Any proposed IT implementation may exhibit various levels of sensitivity to different stakeholders at different times and also to all stakeholders over the course of time. The project's sensitivity to these challenges or changes in the environment will rely on the establishment of a support team to ensure conformity of a project's various elements and initiatives.

RFI/RFP/RFQ

The various processes of systems planning and systems analysis including determining the strategic objectives, defining the usability requirements, completing the various aspects that contribute to the functional needs assessment and determining the buy vs. build strategy, all contribute to the acquisition strategy. If a decision is made to buy a product, a formal selection process takes place and this is discussed more in [Chapter 6](#). However, in these earlier phases the information gathering regarding viable products and vendor selection begins with the request for information (RFI) and request for proposal (RFP) processes. Through these two processes, the organization should be seeking to understand:⁹

- Does the vendor share the same vision for the product as the organization?
- Does the product meet the key functionality needed to achieve the organizations strategic objectives?
- Does the product/vendor utilize the appropriate technology?
- Does the vendor qualify in regards to the organizations acquisition policies?
- Can the vendor support the organizations implementation strategy?
- What is the vendor's track record for operations and maintenance support?
- What is the vendor's viability in the market?

Request for Information

RFIs are not utilized today as much as they used to be. With the popularity of information sharing through web services and trade shows, much of the information that has traditionally been requested through the RFI process is largely available on a company's website and through demonstrations. However, a RFI is intended to be an informal request for information that does not require commitment from either party. It is a collection of documents designed to collect information regarding prospective vendors and their ability to meet the defined need or high-level requirements. Should an organization still desire to execute the RFI process, it is generally a two or three page set of questions on the following areas:⁹

- Company background (size, years in business, number of employees, product lines)
- Product information (product name, product history, technical platform, overview of product capabilities)
- Market information (major competitors and identification of key differentiators)
- Installed base and clients (number of products the company has sold, how may they are currently implementing, number fully installed)
- Special criteria (anything that the vendor has identified as unique or established as critical)

This information in combination with website research should result in a pool of about 10 to 20 products/vendors, with the intent to narrow this list down to only

a handful to further evaluate. Tools like a vendor comparison map, which can be used to plot responses to key criteria and help narrow down the large list of vendors to the smaller list to pursue further.

Request for Proposal

Once the list has been narrowed, the organization should then complete the RFP process. The RFP is a formal request sent to vendors that ultimately leads to a contract between the organization and the selected vendor(s). This process is used to obtain more detailed information with more specificity placed on what the organization has identified as their system requirements. All vendors are asked the same questions, which helps foster a more consistent review and selection process. It would be most appropriate to send the RFP to the four of five vendors that seem to best fit the organization's overall criteria. Note here that the number of RFPs sent may also be dependent on the type of organization. Public organizations may be required to send RFPs to every eligible vendor. In general, RFPs have some fairly typical components including:⁹

- Organizational profile (describes the organization seeking the new vendor including; basic demographics, mission and goals, vision for the product(s), current information infrastructure, any specific constraints, instructions for responding to the RFP, how many copies will be sent and how vendor questions will be directed)
- Vendor information (description of its demographics (size and longevity, years in business, revenues, profitability, number of employees), product research and development history and plans, types of installations (number, size, status), corporate composition, references, user group information and contract history)
- Functional specifications (description of functional capability and processes and workflows the product supports)
- Operational requirements (data architecture, analytical processes supports, necessary interfaces, reliability and security features, system capacity, expansion capabilities, response time, downtime and other system maintenance issues)
- Technical requirements (vendor should propose the appropriate technical architecture to meet the organization's functional specifications and operational requirements, specific hardware and networking and software requirements)
- Application support (the proposed implementation schedule describing data conversion, acceptance testing, training and documentation, ongoing support and maintenance, which may include information regarding any service level agreements (SLAs) and upgrades)
- Licensing and contractual details (supply the specific bid for one-time and recurring costs based on the organization's requirements, standard contract,

financing arrangements, proposed relationship with hardware vendors, warranty information, any clauses that protect the organization should the vendor go out of business)

- Evaluation criteria (provided to let the vendor know up front the most important elements of the evaluation and how certain factors are weighted)

Request for Quotation

Although a RFP may include pricing information (as described above in the licensing and contractual details description), it has also become more commonplace to also complete a request for quotation (RFQ) or a request for bid to obtain a price from which to negotiate.⁸ This approach can help minimize the influence of cost from the other critical evaluation factors obtained through the RFP process. The RFQ can be more suitable than the RFP if the organization has thoroughly studied products and concluded that a small number are very similar.

Non-Disclosure Agreement

As part of these processes, organizations should also consider sending a non-disclosure agreement (NDA) or confidentiality agreement to each vendor. The purpose of an NDA is to protect both companies from disclosing confidential information. An NDA includes legal terminology that, in effect, states that the vendor cannot disclose information about your company to anyone without your express permission. It may also be written as a two-way NDA, meaning that the organization cannot disclose information either.¹⁶ Any vendor who is being sent confidential information about your company should be sent the NDA and this should be signed and executed prior to releasing any information about your organization. In some cases, similar terms regarding confidential information that is exchanged between parties may be included in a master client agreement rendering an additional NDA unnecessary. Breaching these types of agreements can be very costly, so it is very important to understand the terms on agreement and identifying what is considered confidential.¹⁶ Your organizations legal counsel should be involved in reviewing the terms of any agreements that are signed.

Cost–Benefit Analysis

The information obtained from these processes, more so the RFP or RFQ, can also be used to inform a cost–benefit analysis (CBA). A CBA is a process that uses quantitative techniques to evaluate and measure the benefit of providing products or services compared to the cost of providing them.⁹ The CBA is going to evaluate both the costs (considering things such as hardware, software, installation and training, maintenance and support) and the benefits (considering things such as cost savings or avoidance that are achieved by the new functionality [e.g. charge capture, decision support, diagnostics studies,

financial management, medical record operations, nursing department, referral management, etc.]). Taking into consideration the costs and achieved benefits, the net impact is determined for each year by subtracting the cost from the benefits (in Figure 4.4 below this in depth CBA factored in the present value (PV) and determined the accumulated net present value (NPV)). A typical period is established, such as five years, and the exercise is repeated for each year identifying both the costs and benefits for each year. The CBA also visually shows how costs change over time, e.g. many being front-loaded with lower ongoing costs or some being one-time costs and how and when benefits are realized. Once the costs and benefits are mapped, it becomes easier to identify how long it will take to achieve the payback period of the investment and furthermore when the organization will actually see a financial benefit from the implementation and provides that validation that the benefits of the recommended solution are equal to or greater than the costs.

Figure 4.4 provides a sample of a cost–benefit analysis.

All of this information is used to inform the system selection process, which is discussed in more detail in Chapter 6.

Item	2006 (0)	2007 (1)	2008 (2)	2009 (3)	2010 (4)	2011 (5)	2012 (6)	2013 (7)	Total
Cost									
System costs									
System infrastructure	1,241	-	-	-	98	93	88	84	1,604 (10.0)
System application	1,006	1,274	315	192	188	184	179	174	3,512 (21.9)
Office supply	306	286	-	105	102	98	95	91	1,084 (6.7)
Sub-total	2,554	1,560	315	296	388	375	363	348	6,199 (38.6)
Induced costs									
Paper-charts scan	-	-	724	519	-	-	-	-	1,243 (7.7)
MTs support	166	1,186	1,107	1,118	1,185	1,313	1,255	1,281	8,612 (53.6)
Sub-total	166	1,186	1,831	1,636	1,185	1,313	1,255	1,281	9,854 (61.4)
Total PV of annual costs	2,720	2,746	2,146	1,934	1,573	1,687	1,618	1,630	16,054 (100.0)
Benefit									
Cost reductions									
Supplies for paper-charts	11	52	258	100	248	91	231	3	1,076 (5.5)
Chart storage space	-	-	14	145	142	139	135	129	703 (3.6)
Chart management FTE	-	-	180	782	799	847	816	807	4,231 (21.5)
Clerks decreased	-	-	165	165	165	165	165	164	990 (5.0)
Supplies for MDIS	7	67	78	415	168	165	161	155	944 (4.8)
Sub-total	18	120	695	1,335	1,522	1,408	1,507	1,339	7,945 (40.4)
Additional revenues									
From remodeling storage	-	-	-	17	26	35	25	21	125 (0.6)
From temporary storage	-	-	261	300	280	275	269	262	1,646 (8.4)
From MT support	-	-	551	1,411	1,421	2,747	1,928	1,899	9,956 (50.6)
Sub-total	-	-	811	1,728	1,727	3,056	2,223	2,182	11,727 (59.6)
Total PV of annual benefits	18	120	1,506	3,063	3,249	4,465	3,731	3,521	19,672 (100.0)
Accumulated NPV	(2,702)	(5,329)	(5,969)	(4,839)	(3,163)	(385)	1,726	3,617	
Benefit-cost ratio									1.23
Discounted payback period									6.18

Figure 4.4 Cost–Benefit Analysis (Unit: 1,000 US\$)¹⁷

**Applied currency exchange rates: 1US\$= 1,100K.*

Summary

Implementing a new system requires a thorough analysis of current processes and workflows, documentation of requirements and identification of future-state workflows, with careful consideration given to usability and end user acceptance. Project planning and control helps to ensure the project will meet objectives and be completed on time and within budget. In some cases, requirements will lead to the generation of an RFI and RFP, which are used to inform the system selection process. Planning for the implementation is a critical step and must factor in migration, either from paper or from one system to another. If the project involves an EHR, the IT staff must remain abreast of both regulatory and technological developments to ensure that the clinical system remains current to achieve goals of improved efficiency, quality and patient safety, increased patient engagement, improved care coordination and better measures of population health management.

References

1. Deloitte. Reinventing tech finance: The evolution from IT budgets to technology investments. CIO Insider. January 2020. https://www2.deloitte.com/content/dam/insights/us/articles/6300_CIO-insider-tech-finance/DI_CIO-Insider_Tech-Finance-Budgets.pdf (accessed August 25, 2021).
2. Rave Mobile Safety. Healthcare IT Budgets Forecasted to Increase by 8.8%. <https://www.ravemobilesafety.com/blog/healthcare-it-budgets-forecasted-to-increase> (accessed August 11, 2020).
3. HIMSS. *HIMSS Dictionary of Health Information and Technology Terms, Acronyms and Organizations, Fifth Edition*. Boca Raton: Taylor & Francis Group, LLC, 2019.
4. Tutorial Points. Systems Analysis and Design – Quick Guide. https://www.tutorialspoint.com/system_analysis_and_design/system_analysis_and_design_quick_guide.htm (accessed June 4, 2020).
5. Journal of Community Hospital Internal Medicine Perspectives. *The alarming reality of medication error: a patient case and review of Pennsylvania and National data*. 2016; 6(4) <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5016741/> (accessed August 25, 2021).
6. TechTarget. *Gap Analysis*. <https://searchcio.techtarget.com/definition/gap-analysis> (accessed June 4, 2020).
7. Armoni A. *Effective Healthcare Information Systems*. Hershey, PA: IRM Press, 2002.
8. Spekowius G, Wendler T. *Advances in Healthcare Technology Shaping the Future of Medical Care*. Dordrecht, Netherlands: Springer, 2006.
9. Amatayakul MK *Health IT and EHRs, Principles and Practices, Sixth Edition*. Chicago: AHIMA, 2017.
10. National Council of State Boards of Nursing. New nurse toolkit. Chicago: National Council of State Boards of Nursing. <https://ncsbn.org/QI-FlowChar.pdf> (accessed April 22, 2016).
11. Hertfordshire Partnership NHS Foundation Trust. Schedule 4—Patient booking. Hertfordshire, UK: Hertfordshire Partnership NHS Foundation Trust.